Author: Georges Sideratos*

National Technical University of Athens   joesider@power.ece.ntua.gr

Background :

So far, most wind power forecasting models aim to produce the best forecasts for every possible case, without any specific consideration for critical events. These events, characterized as extreme power system events, are straightforward related with the low predictability of the wind power and critically affect the overall performance of the wind power forecasting models. Any improvement of the wind power forecasting performance can provide additional benefits to the end-users (TSOs, wind farm operators etc.). Several regimes can be defined based on the different wind power profiles that lead to large forecasting errors and related to specific meteorological events. The regime-switching approach gives the opportunity to predict wind power with a different predictor for each regime, reducing essentially the forecasting error.

New regime switching approach using neural networks

A new regime switching method based on artificial intelligence was proposed to produce better wind power forecasts at extreme events cases comparing with the state-of-art. Firstly, the extreme events are grouped to six different regimes. For the identification of extreme events, two different power curve models are used together with a continuous wavelet analysis. The under-estimation or over-estimation of wind power by the power curve models indicates intensity errors and phase errors related mainly to ramp events. Finally, setting a threshold to the coefficients of the continuous wavelet analysis divides the wind power timeseries in periods with high variability and low variability. By this way, the three regimes described above are divided to six regimes depending on the wind power timeseries variability.

Next, the Bayes rule and the radial basis function models are integrated in a ARTMAP network forming the novel RBF-pARTMAP network. The RBF-pARTMAP is used to estimate the probability occurrence of each regime. The final prediction is obtained from the combination of the regimes probabilities with the predictions of the six RBFNNs. For on-line operation, a novel adaptive learning algorithm is applied that enhances the RBFNNs performance using the new observations. The evaluation of the regime switching model at the real wind farm shows significant improvement of wind power forecasting over state of the art models, especially in cases of extreme events.

Overall performance

- Evaluated on a real case study with one year period data
- Always better performance than persistence except the first one hour time step.
- 12.5% global improvement compared to state of the art methods considering the NMAE criterion.

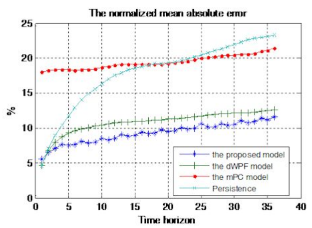
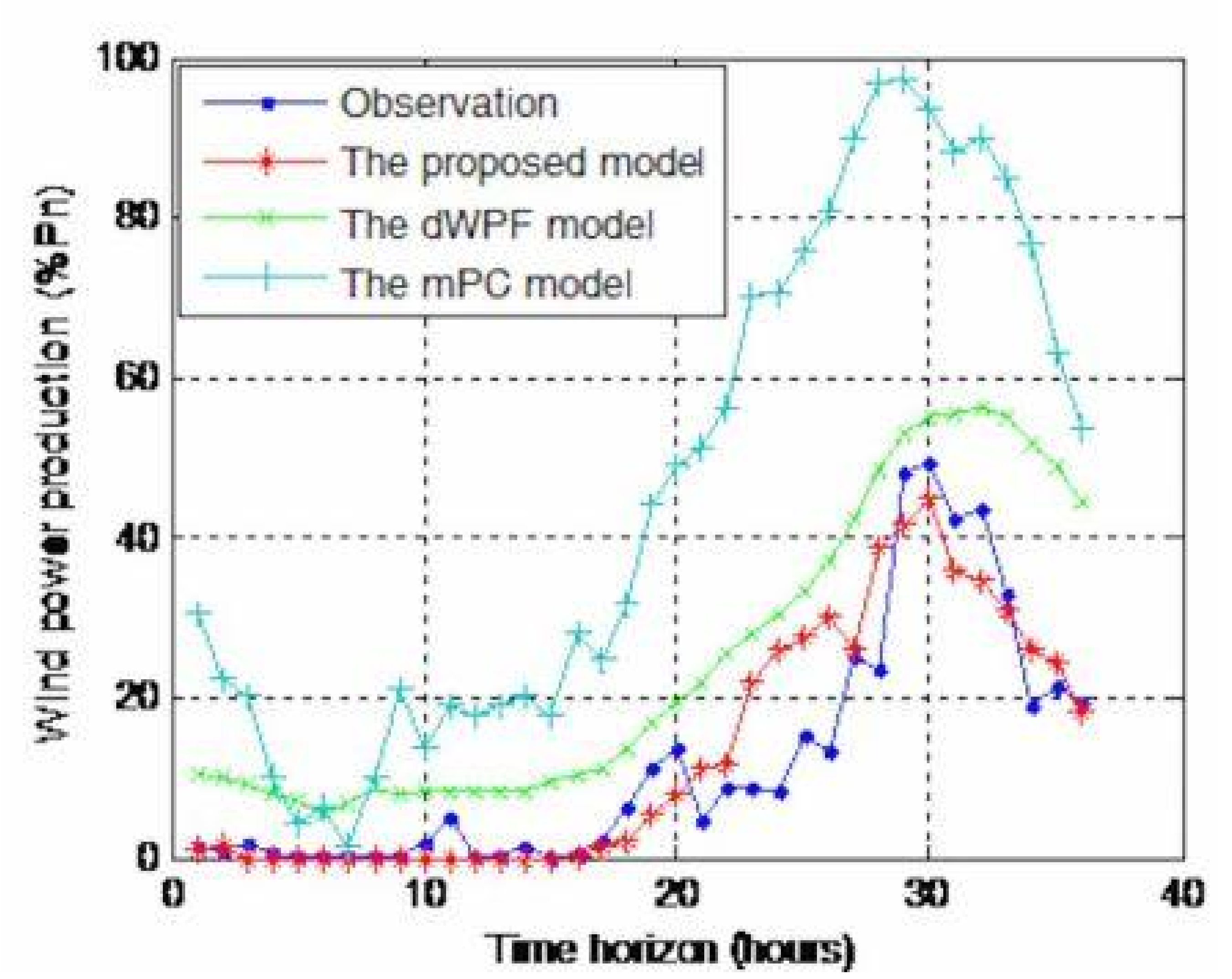
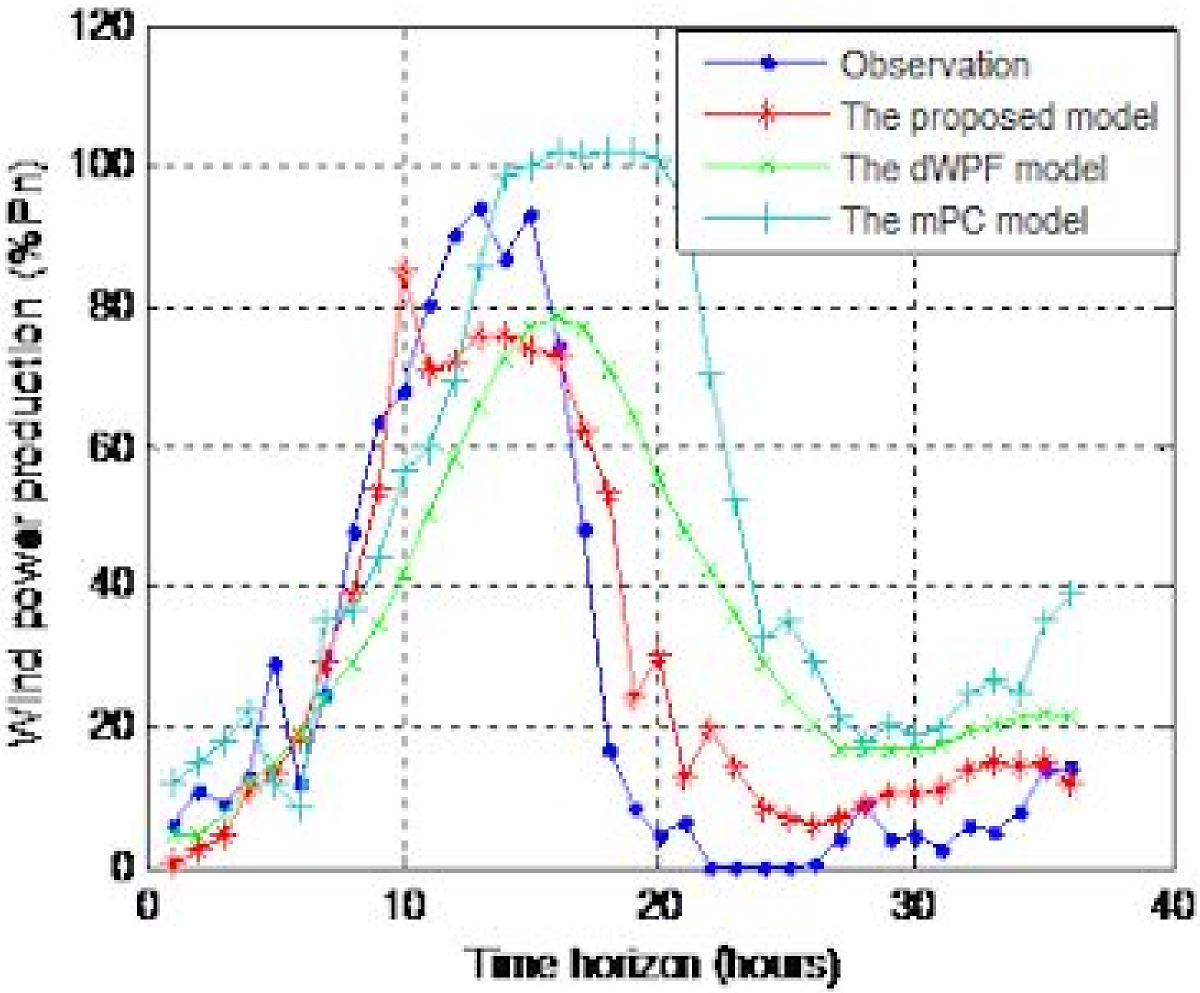


Figure 1. The NMAE of the regime switching model, of the state-of-art dWPF model [1] and of the persistence for every look-ahead time

Performance on extreme even

- Large improvement at the extreme events





Further work:

Our purpose is to improve the performance of the RBF-pARTMAP network for more accurate regime estimation as well as new adaptive methods for RBFNNs will be developed.

Bibliography:

[1] Sideratos G, Hatziargyriou N (2007). An Advanced Statistical Method for Wind Power Forecasting. IEEE Transactions on Power System, Vol. 22, Issue 1, pp. 258-265

[2] Sideratos G, Hatziargyriou N (2012). Wind power forecasting focused on extreme power system events. IEEE Transactions on Sustainable Energy, Vol. 3, Issue. 3 pp. 445 – 454, available online